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ABSTRACT

The development, administration, results of administration, and limitations and problems of the Comprehensive Mathematics Inventory (CMI) are discussed. The CMI is an instrument for assessing mathematics competencies of children prior to or at the instance of entering school. In a pilot test of the CMI, 727 children in their first full week of school were administered the 200-item inventory. The items are included in subtests concerning number, money, measurement, pattern identification, recall, vocabulary, and geometry, in addition to which there are six open ended items. Results of the testing showed that the sample varied considerably in knowledge and skill, and point up the need for flexible, informal programs for beginning instruction. (DB)

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THE COMPREHENSIVE MATHEMATICS INVENTORY: A Research Instrument for Assessing Mathematics Achievement in Early Years

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Primary and upper grade teachers can usually find pertinent information concerning pupil strengths and weaknesses by reviewing cumulative records and talking with previous teachers. Kindergarten and pre-school teachers and frequently first grade teachers do not usually have any information available to them concerning the competencies and especially the math competencies of their pupils. This information is of course vital to the success of curricular programs where individualized learning experiences are provided. Such experiences simply must be commensurate with the child's ability level, and ample evidence (3 and 4) exists to verify that ability levels at this early age are extremely varied.

Information concerning pupil performance and ability levels will be no better than the means used to collect such data. Few instruments have been developed to assess the mathematics competencies of children prior to or at the instance of entering school, and even fewer have been developed to the point of availability. The Comprehensive Mathematics Inventory (CMI) is

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one such instrument which the authors have been developing (1). Several research articles have already been published using the CMI as a basic data gathering device, and at least a dozen widely scattered research projects from small to quite large are currently underway that will provide further information concerning both CMI results and evaluations and comparisons of the instrument itself.

The balance of my segment of time here will be devoted to highlighting certain aspects of the CMI and I will also suggest some of the things it does Not do.

Test development:

The CMI was developed over a two year period during which the investigators examined published materials for Kindergarten and first grade programs, examined professional texts for teacher training in mathematics, and used the experiences of kindergarten teachers to devise potential instrument items. The item pool was then examined for duplication and certain items were rejected as being obviously of little value in providing information.

This process resulted in an experimental item pool of 200. Each item was field tested in the Laboratory School, University of Missouri-Columbia, was revised if necessary on the basis of those trials, and the initial form of the CMI was developed. The 200 items were grouped according to the curricular topics from which they were drawn as follows in Table 1.

Table 1

Items	Subtests
50	Number
22	Money
34	Measurement
7	Pattern Identification
20	Recall
27	Vocabulary
34	Geometry

As you have noted, the item total above is only 194. There were six open ended items--such as placing 20 disks on a table and asking the child to count the disks. These responses provide information relative to the child's mathematical competence but did not yield a right-wrong or correct-incorrect response.

Test Administration:

The CMI is individually administered with a booklet presenting each item, materials necessary (from an accompanying shoe-box kit), and correct response, with space for the child's response whenever unusual enough to record. The test was divided into two parts to prevent fatigue in one long session. Each part took 15 to 20 minutes with total time varying between 35 and 40 minutes.

A group of examiners was employed from the student bodies of the Columbia and St. Louis campuses. Forty-three students, seniors or graduate level, from the teacher programs of the two

campuses were given a training program consisting of three half-day sessions with directed outside familarization practice and administration practice. A video tape of testing with the CMI provided an opportunity to work on administration and scoring questions as did a "live" session through a one way mirror in the Reading Clinic facilities at the St. Louis campus. While statistical data were not gathered on scorer agreement, virtual unanimity was observed in the group sessions.

Since our pilot of the CMI was directed toward assessing the competencies of youngsters entering school, it was necessary to complete data gathering prior to possible instructional contamination. Our pilot project involved 30 kindergarten sessions from six different school districts, chosen to represent the widely varied communities of a modern metropolitan area. Selecting only the youngsters present in the sessions on the date when the examiners were present in their school without attempting to pick up absentees, the pilot group sample included 727 youngsters in their first full week of school.

In addition to examining total and subtest scores for all kindergarteners, a number of analysis were made with respect to variables such as those in Table 2.

Table 2

Previous education
Age
Siblings
Father's education
Mother's education
Father's occupation
Sex
Race

Most of these findings have been reported elsewhere (see bibliography) and need not be repeated here. However, certain major findings may be worth at least a summarization here. Our analysis of differences among racial groups yielded significant (in the practical sense) information(5). We found that black youngsters in the integrated suburban districts whose families were largely middle class by virtue of their occupations and residence areas, did significantly better on the CMI than did their ghetto counterparts providing still more evidence for what we consider to be the answer to the old question of racial ability. Perhaps even more interesting is the fact that the suburban black group scored consistently higher than their white classmates though this difference was neither statistically nor practically significant. Hopefully future research in this area will delve

into the possibility of the development of an "academic achievement syndrome" in the middle class suburban black group similar to those developed historically by the German immigrant group or the Jewish communities. Many educational ills and perhaps some currently painful social ills would be greatly alleviated by such a development.

In general we found our sample group to vary greatly in knowledge and skill just as earlier research has suggested(2). However, we also found considerable evidence of similarity in competence within particular school groups. In some instances, groups were found to possess at their entry into kindergarten nearly all of the math concepts planned for them in the kindergarten programs and materials and even much of the 1st grade curriculum. On the other end of the competence curriculum were those of vitually no skills or knowledge.

These findings lead us to be more firmly in favor of a flexible, informal program for beginning instruction which can be based on inventories and which will result in more closely aligning experiences with the children who need them and can benefit from them. We are convinced that too many youngsters are involved in programs beneath or beyond their capabilities even in these first formal school experiences.

Limitations and problems:

The CMI results were examined for evidence related to the sub-test arrangement which had been derived from the instructional or curricular topics dealt with in school materials and programs.

A factor analysis revealed that these sub-tests were not assessing seven independent areas and only one factor, a large general factor, accounted for nearly all of the variance in CMI results. This outcome is not surprising because the general factor of quantitative ability and achievement is inherent in each of the mathematical topics of number, measurement, geometry, etc. Neither do we feel that the sub-tests should be eliminated since school instruction is topically arranged and since individual competence in each sub-topic does vary sufficiently to be a profitable source of instructional planning.

Recent wide spread interest in the work of Piaget and more specifically in the concept of levels of cognitive development is not directly aided by using the CMI. The Piagetian kinds of tasks and/or "experiments" were not incorporated into the CMI.

Prescriptions for treatment are not directly provided by the test. However, we have received some evidence that teachers whose classes have been assessed do avail themselves of the materials used and especially of the opportunity to expand or modify their programs in mathematical areas previously described. While the CMI assesses levels of achievement, it does not provide a program for instructing the levels once established.

Finally for those who may enter into a project or program with young children, we would emphasize the problem of communication. Quite often, the child's first response or even set of responses may not truly indicate presence or absence of knowledge or ability.

As one example of what is meant here, consider the common response we received to the question "What is this?" while pointing or holding a yardstick. Many children answered "a whoppin stick" at first; but several did know its application in measurement when stimulated by an additional question,"Do you know what else it is used for?"

Publications Related to the COMPREHENSIVE MATHEMATICS INVENTORY

1. A copy of the CMI is available. Order NAPS document 00613 from ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 22 West 34th Street, New York City, New York 10001. Remit $1.00 for microfiche or $3.00 for photo copies.

2. Glennon, Vincent J. and LeRoy G. Callahan Elementary School Mathematics: A Guide to Current Research. Washington, D.C.: Association for Supervision and Curriculum Development, National Education Association, 1968.

3. Rea, Robert E. and Robert E. Reys, "Competencies of Entering Kindergartners in Geometry, Number, Money, and Measurement", School Science and Mathematics, 71:389-402, May 1971.

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